Effect of Response Mode and Subject Characteristics On Learning in Programed Instruction

By

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Abstract

60 Ss took a program in one of three ways: writing the answer, 'thinking" the answer without writing it, or reading a program with the answers filled in. Results indicated no significant differences among the groups on two measures of amount learned. Low positive correlations were obtained between amount learned and IQ and reading comprehension of the Ss. Percent error on test frames within the program was negatively correlated with adjusted gain scores ($r = -0.71$). Results were also related to possible pragmatic applications.

A common assumption in programed instruction has been that overt responding (verbal, written, or manipulative), suitably reinforced, leads to greater learning than does covert responding (Holland, 1959). Early evidence contrary to this assumption was presented by Evans (1960). His results were further substantiated by Alter and Silverman (1962), Krumboltz and Weisman (1962), Goldbeck and Campbell (1962), Wittrock (1963), Tobias and Weiner (1963), and Feldman (1965). Tobias and Weiner conclude their study of response modes with the statement that, "The crucial experiment in this area would be one with a long, well-standardized program, used in a conventional course of instruction (1963, p. 13)." The present study is such an attempt to investigate the effects of varying response parameters in the context within which they are designed to operate: that is, the classroom.

Method

Program. A programed course of instruction in ratios and proportions constructed by the General Programed Teaching Corp. was taken by all three groups. The program used is an especially good one, as is evident in an evaluation and comparison of it with other programed texts conducted by McGuigan (1965). The program contained 1344 frames, of which 69 were test frames to which the correct answer was not available to the student. These frames were labeled TEST and were distributed at variable intervals throughout the program. Most of the frames were of the constructed response type although some frames were of the true-false or multiple-choice variety. A special slider template was used with the programed text to cover the correct answer and the next frame while the student read and responded to each frame.

Subjects. The **Ss** were 60 sixth grade students in two classrooms in the Roanoke, Virginia, City Public School System. They were randomly assigned to three groups of 20 each and there were an equal number of **Ss** from each class in each group. Lorge-Thorndike Intelligence Test scores and scores on the Reading Comprehension Scale of the Science Research Associates Achievement Test were obtained from the school records of these **Ss.**

Procedure. The program was administered by the teachers to a group of the elementary school students for whom it was designed, as part of the regular arithmetic work at the time when ratios and proportions would normally have been taught. This was done so that the motivational and attentive levels of the students would be on as nearly as possible the same as that on any other school day. The arithmetic period, during which the program was administered, lasted approximately 45 minutes each day. The students were not told that they were involved in an experiment; but, although programs have been used in the Roanoke schools for several years, they were probably aware of the fact that they were not all taking the program in the same manner.

The overt responding (**OR**) group took the program in the normal manner, writing their responses in the book and then moving the slider to confirm the answer. The covert responding (**CR**) group followed a similar procedure except that they were instructed not to write in the programs; but to the TEST items all groups wrote their responses. They were to read the frame, think of the answer, and then move the slider to see if they were right. The no-response (**NR**) group read a program which had the answers already filled in and the response confirmation portion of the frame blacked out.

A 40 item multiple-choice achievement test devised for use with the program by the General Programed Teaching Corp. as a pre- and post-test was used by the teachers.

Results

One-way analyses of variance conducted among the three groups on pretest scores, IQ's, and reading comprehension scores failed to indicate any significant differences at the .05 level among groups on these variables. An adjusted gain (**G**) score was obtained by dividing the actual gain (post-test score minus pre-test score) by the possible gain (total score possible on the test minus pre-test score). McGuigan (1963) has found this **G** score to be a more accurate index of achievement since it adjusts for differences in individual's prior knowledge as exhibited in pre-test scores. Analyses of variance of the two indices of achievement, percent error on the test frames and **G** scores, also failed to reach significance, again at the .05 level. (Tables 1 and 2). Results of a Duncan's Range Test indicated a significant difference between the **OR** and **NR** groups on time to complete the program. Table 3).

TABLE 1
Summary of Analysis of Variance of Percent Error on Test Frames

Source	df	Mean Square	F	p
Among Groups	2	84.69	1.10	>.05
Within Groups	57	76.96		
Total	59			

TABLE 2
Summary of Analysis of Variance for Adjusted Gain (G) Scores

Source	df	Mean-Square	F	p
Response Mode	2	0.02	0.40	>.05
IQ	1	0.16	3.20	>.05
Mode x IQ	2	0.00	0.00	>.05
Error	42	0.05		
Total	47			

TABLE 3
Results of Duncan's Range Test Among Groups on Time in Minutes to Complete the Program

OR Group	CR Group	NR Group
482.45	425.25	386.45

Any two treatment means not underscored by the same line are significantly different ($p<.05$).
Any two treatment means underscored by the same line are not significantly different.

G scores were found to be significantly correlated with IQ($r=0.34$, $p<.05$) but not with reading comprehension ($r=0.21$). Percent error on the test frames and **G** scores were also correlated ($r=-0.71$, $p<.01$).

Significant correlations were found to exist between IQ and **G** scores for the **OR** group ($r=0.39$, $p<.01$) and for the **CR** group ($r=0.38$, $p<.01$) but not for the **NR** group ($r=0.22$). A χ^2 Test of Homogeneity or r's did not, however, find these correlations to differ significantly from each other ($\chi^2=0.368$).

The **G** scores of the **NR** group were

significantly correlated with scores on the reading comprehension test ($r = 0.36$, $p < .01$) but these two variables were not significantly correlated in the **OR** group ($r = 0.14$) or in the **CR** group ($r = 0.17$). A χ^2 Test of Homogeneity of these r's failed to yield significance ($\chi^2 = 0.461$).

Overall, it can be said that all correlations between **G** scores and subject characteristics were low. A summary of means of measures of achievement and time to complete the program is presented in Table 4.

TABLE 4

Means of Measures of Achievement and Time to Complete the Program

	OR Group	CR Group	NR Group
Mean % Error on Pre-test	49.5	50.9	43.0
Mean % Error on Post-test	79.5	78.9	73.7
Mean % Gain	30.0	28.0	30.7
Mean (G) Score	0.61	0.61	0.55
Mean % Error on Test Frames	8.7	11.4	12.7
Mean Time to Complete Program	8 hr. 2 min.	7 hr. 5 min.	6 hr. 26 min.

The analysis of variance in Table 2 is for a 3 x 2 factorial design with 8 **Ss** per cell and shows that the **Ss** with high IQ's did not achieve significantly higher **G** scores than the **Ss** with IQ's below the mean in each group. A zero interaction was found between IQ and response mode with respect to **G** scores.

Discussion

Since there were no significant differences among the three groups in IQ, reading comprehension test scores, and pre-test scores, the assumption that the groups were equivalent prior to taking the program seems to be justified.

The results of this study confirm those of Alter and Silverman (1962) and a number of others previously cited, (e.g., Krumboltz and Weisman, 1962; Goldbeck and Campbell, 1962; Wittrock, 1963; Tobias and Weiner, 1963; Feldman, 1965) in failing to show significant differences in achievement among groups using the different response modes of writing their responses, thinking them, and reading an altered program. Perhaps the effectiveness of programs for some subject populations is as much a function of systematic presentation of the "bits" of information as it is of the reinforcement contingent upon individual overt responses. That is, when information is presented in a systematic programed form, adequate reinforcement provided at the end of the chain of responses which comprise the program may be sufficient to maintain the desired behavior. What constitutes adequate reinforcement is an empirical question depending on the reinforcement histories of the subjects; for other populations, such as the culturally deprived or mentally retarded, stronger and more frequent reinforcement contingencies would still seem indicated. Nevertheless, since it may take less time to complete a program which does not require responses as such, it might be wise to consider for some applications, the advantages of simply presenting the information to be learned in systematic step by step form, without requiring written responses, and providing suitable reinforcement contingent on completion of the program.

The low correlation of the **G** scores with IQ and their nonsignificant correlation with reading comprehension further emphasize the inherent advantages of programed instruction in teaching students of lesser ability, since the effects on performance of individual differences in these abilities are at least minimized. It seems that individual differences among the **Ss** on this program appear more as differences in time to complete the program than as differences in final performance. This effect has also been noted by Carroll (1963).

The percent error on the test frames within the program was highly negatively correlated with the **G** scores ($r = -0.71$). Since error rate on the test frames is so well correlated with **G** scores it seems safe to assume that error rate on the other frames would be similarly correlated, which would support the Skinnerian position on reducing error rate on programs to the lowest level possible (Skinner, 1954; Zeaman, 1962).

The fact that the **G** scores of the high IQ group were not significantly higher than those of the low IQ group is evidence that programing can minimize the effect of individual differences on performance. Furthermore, it is interesting to note that the **NR** group had the lowest correlation of IQ with **G** scores, even though this correlation did not differ significantly from those of the other two groups. The **G** scores of the **Ss** are not differentially affected by IQ since the results of the analysis of variance also show no interaction with response mode.

An interesting point for speculation arises in the results of comparison of the reading comprehension correlations. Reading comprehension is not significantly correlated with achievement for the sample as a whole or for either the **OR** or **CR** groups but is correlated at the .01 level of significance for the **NR** group, who **read** the altered program. If this effect does in fact exist it would seem judicious to require only those with poor reading comprehension to make overt responses while others take the program using less time-consuming response modes. Further research with this parameter of programed learning would seem to be worthwhile.

It should be noted that the above conclusions are not necessarily universal for all programs, particularly in the case of material of a different degree of difficulty.

References

Alter, M. & Silverman, R. E. The response in programmed instruction. **J. prog. Instruction,** 1962, **1,** 55-78.

Carroll, J. B., Programed instruction and student ability. **J. prog. Instruction,** 1963, **2,** 7-11.

Evans, J. L. An investigation of "teaching machine" variables using learning programs in symbolic logic. In R. Glaser and J. I. Taber (Eds.), **Investigations of the characteristics of programmed learning sequences,** report prepared under the Cooperative Research Program (Project No. 691), U.S. Office of Education, University of Pittsburgh, 1961, pp. 31-82.

Feldman, M. E. Learning by programed and text format of three levels of difficulty. **J. edu. Psychol.,** 1965, **56,** 133-139.

Goldbeck, R. A. & Campbell, V. N. The effect of response mode and response difficulty on programed learning. **J. educ. Psychol.,** 1962, **53,** 110-118.

Holland, J. G. Teaching machines: an application of principles from the laboratory. In W. I. Smith & J. W. Moore (Eds.), **Programmed learning: theory and research.** New York: Van Nostrand, 1962, pp. 34-48.

Krumboltz, J. D. & Weisman, R. G. The effect of overt versus covert responding to programmed instruction on immediate and delayed retention. **J. educ. Psychol.,** 1962, **56,** 89-92.

McGuigan, F. J. & Peters, R. J., Jr. Assessing the effectiveness of programmed texts-methodology and some findings. **J. prog. Instruction,** 1965, **3,** 23-34.

Skinner, B. F. The science of learning and the art of teaching. **Harv. (educ.) Rev.,** 1954, **24,** 86-97.

Tobias, S. & Weiner, M. Effect of response mode on immediate and delayed recall from programmed materials. **J. prog. Instruction,** 1963, **2,** 9-13.

Wittrock, M. C. Response mode in the programing of kinetic molecular theory concepts. **J. educ.) Psychol.,** 1963, **54,** 89-93.

Zeaman, D. Skinner's theory of teaching machines. In W. I. Smith & J. W. Moore (Eds.), **Programmed learning: theory and research.** New York: Van Nostrand, 1962, pp. 49-56.

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